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AIRCRAFT ARMAMENTS, Inc.

ENGINEERING REPORT
PHASE III

E41R1 POINT SOURCE GAS ALARM

Covering Period
8 September 1961
thru
14 October 1961

ER-2538
REPORT NO.

November 1961
DATE

APPROVED:

C.A. Bartenfelder - Project Manager

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AAINC E135A

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I. INTRODUCTION

This report describes the progress of the E41R2 Point Source Gas Alarm Program at AAI for the period from 2 September through 14 October 1961 as performed in accordance with the requirements of Contract No. DA-18-108-CWL-6553. Included herein is a description of the engineering and manufacturing action performed at AAI under Phases II and III of the subject contract and a brief description of the CONARC Test Program now in progress at Fort Benning, Georgia. As previously reported, all effort on the Phase I program has been completed.

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II. SUMMARY OF WORK PERFORMED

Alarm numbers 38 through 43 have been completed and subjected to the predelivery checkout tests described in the previous progress report. Alarms 38, 39 and 40 have been delivered to CWDL and are now being readied for the FET Program. Manufacturing efforts are now in progress on the last group of fifteen (15) E41R2 Alarms which are scheduled to be completed on 1 December 1961.

The preparation of the final Class I drawing for the Phase III Program has been completed and the drawings delivered to the Army Chemical Center ENCOM for their evaluation. These drawings have been released to the AAI Manufacturing Division and the fabrication of detail parts for the one master model is now in progress.

R&D efforts were continued during this period with major emphasis being placed on photocell and photometer studies, bridge circuit design and test, automatic restandardization, inlet heater studies, remote alarm and waterproofing tests.

III. DETAIL DISCUSSION OF PROGRESS

A. Phase II Program

Manufacturing is now in progress on parts that are to be delivered to CRDL for use as spares in conjunction with the Ft. Benning Test Program. With the delivery of this item, all action required under the Phase II portion of the subject contract will be completed. These parts are now scheduled for delivery on 1 December 1961.

B. Phase III Program

1. Class I Drawings

All Class I drawings have been completed and a set of reproducibles and two sets of prints were delivered on 6 October 1961 to ACC ENCOM for their evaluation. These drawings reflect all changes incorporated into alarms 35, 36 and 37 as determined by CRDL, Final Engineering Test Division, AAI and Ft. Benning testing. Changes found necessary as a result of the ENCOM review are to be incorporated and the completed drawing delivered on 5 January 1962. Also delivered to CRDL during this period was a complete set of reproducibles of the AAI Class II drawings for the current alarm design.

2. Fabrication, Testing and Delivery

Fabrication of alarm numbers 38, 39 and 40 has been completed and all the necessary checkout testing accomplished. These alarms have been delivered to CRDL and are to be used as the FET test models. Serial numbers

41, 42 and 43 were also completed and the final predelivery checkout tests are now being performed. These units are scheduled to be used in the forthcoming Arctic tests at Ft. Greeley, Alaska.

Procurement is essentially complete and fabrication well along on the fifteen (15) alarms scheduled to be completed on 1 December 1961. Completion of the last three units (Nos. 56, 57 and 58) will be held in abeyance inasmuch as several of the major subassemblies for each of these units were utilized in the reconditioning of the three original Ft. Benning alarms (Nos. 14, 21 and 26). It is understood by this contractor that the present contract will be amended to permit the fabrication of the necessary subassemblies but until this is accomplished, final assembly of these alarms can be only partially completed.

The Class I drawings have been released to our shop for the fabrication of one master model (Serial No. 59). Procurement of raw material and the fabrication of detail parts is now in progress. Final delivery is scheduled for 5 January 1962.

3. Research and Development Program

The following discussions summarize the R&D efforts which have been accomplished by AAI in the specific areas indicated. Each item includes a discussion on the need for R&D action, the scope of the current program and the conclusion reached, if any.

a. Photocell Tests

During testing of the E41R1 alarms, considerable difficulties have been experienced with drift during the normal 12 hour operating period. Since this drift could not be attributed to any specific item in the photometer head, it was decided that a thorough study of the photocell properties was necessary. Detail performance characteristics normally available from the manufacturer on items such as the Type 602 photocell were not available in this instance, so this item was suspected more than any other as the primary cause of drift.

A laboratory test fixture was fabricated on which was mounted eleven (11) Type 602 photocells. The photocells were then subjected to runs at various temperature and light conditions with the current thru the cells held constant. Only limited testing was accomplished since the laboratory test facilities were utilized almost constantly in the course of predelivery checkout testing of alarms 30 through 43.

The data which were gathered during these tests was too limited to form a specific conclusion but it indicated an unexpected degree of stability and in most cases, cell resistance actually decreased with time and increasing temperatures. To account for the drift to alarm level, the cell resistance would have to increase with time, temperature and after shut down. Further testing of the Type 602 cells was suspended at the end of this reporting period in order that more test data could be obtained on the Type 605L cells which will be utilized in the bridge circuit and the automatic nulling device, both of which are described later in this report. Testing of the 602 cells will be resumed at a later date.

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b. Automatic Restandardization

As an alternate approach to overcome the drift problem indicated above, CRDL personnel designed and are now testing a circuit which would readjust the meter relay to 100 microamps after each tape transport. Providing such a system could be satisfactorily operated in the alarm, null drift problems would then be eliminated since the null drift which would be encountered during the cycle would be compensated for at the initiation of the succeeding cycle. Storage and other drifts could be accordingly eliminated as encountered.

The circuit as designed by CRDL has been reviewed by AAI with the subsequent suggestion that modifications be made notably in the area of switching. A breadboard of the later approach has been fabricated and is now being tested on a laboratory test fixture for the purpose of testing thermal stability. The new system would increase alarm power requirements by approximately one percent over the present configuration.

Drawings for the revised photometer head are now being prepared and will be released shortly for manufacturing. Sufficient parts will be ordered and fabricated to install test systems in two alarms. The system which will undergo laboratory testing will not represent the final engineered item since design compromises were necessary because of the lead time required on the specific motor and pot needed for the circuit.

A detail test program is now being prepared for the new system which will include sensitivity and stability tests as well as a study of the effects of variation in fluid flow, air flow, temperature, voltage, etc.

c. Bridge Circuit

Another technique now being considered by AAI to offset the alarm drift problem is through the use of a balanced bridge circuit. This circuit is as described in the previous progress report for the subject contract.

Laboratory test models of this configuration have been built, installed in alarms 9 and 11, and are now in test. The photometer head for the bridge circuit was reworked from used standard heads by adding a photocell housing onto the right hand end of the head and obviously does not reflect the final engineered item. This course of action was taken in order that preliminary data could be taken while a more desirable head configuration was being designed and fabricated.

Initial tests performed on these two units were encouraging in that very few false alarms and malfunctions were recorded but they did not possess the desired degree of stability. Alarm No. 9 was subsequently taken to CRDL for sensitivity and stability testing at their facility and during these tests, performed rather poorly. When it was returned to AAI it was found that a large amount of debris had collected in the photometer head covering the thermistor, light filter, photocell and clogging the air passage.

d. Remote Warning System

The U.S. Army Infantry Board at Fort Benning, Georgia has stated that the original remote warning unit is unsatisfactory for general field use. While it meets the MC's and TC's originally specified, it is in fact limited by the requirements to which it was designed.

To obtain a more satisfactory remote warning system, revision of the MC's and TC's is necessary. A draft of the proposed MC revisions was given to AAI and CRDL for comment. If any portion proved economically or operationally unfeasible, this information should be given to the USAIB who would review and revise the proposed MC's as required.

The features now desired are that the remote warning system shall:

a. Operate on 2 conductor WD/TT field cable

b. Contain audible and visible signals that correspond to the alarm proper

c. Contain a continuity check from the remote unit to the alarm

d. Be capable of checking the audible and visual signals, specifically the malfunction light, the alarm light and the alarm buzzer

e. Be capable of operation at a distance of 0 to 10 meters on alarm power only

f. Be capable of operation at a distance of 0 to 1000 meters using a self-contained power source

g. Utilize a power source available at company level supply

h. Give the operator a choice of using or not using the signals at the alarm proper at the time the remote system is connected to the alarm

i. Permit utilization of the alarm headset and the remote unit simultaneously

j. Permit the use of three or more remote units with one alarm

AAI has reviewed the above features and feels that with the exception of items "e" and "h", a satisfactory remote warning system can be designed. Inclusion of item "e" would eliminate item "c" and "d" since no power is available for checking when operation from alarm power is intended. Inclusion of feature "h" would add to chances of operator error, since he would have to rely on memory as to which choice was made. If there is only one mode of operation, no confusion can result. It is felt that the alarm signals being turned off when the remote unit is used would provide the best operation from a security standpoint.

Three (3) remote warning systems' circuits were designed. In the first circuit as much of items "a" through "j" were met as was possible, including items "e" and "h". The second was a simplified version of the

first and would operate with a constant signal for malfunction and an intermittent signal for alarm. Each of these circuits used three (3) relays at the remote warning unit. Two were of the type currently used on the alarm printed circuit board. The third was a larger extra sensitive relay for the continuity check.

The third circuit replaced all three (3) relays at the remote warning unit with transistor switches. Examination of the relays used in the first two circuits showed that use of these relays at one mile required marginal design. A mock-up of the remote warning system using the third circuit has been built and is now undergoing environmental and operational tests. Conclusions will be made at the end of these tests as to the desirability of this circuit.

c. Flasher Circuit Studies

A significant difference has been observed between the operation of the E41 Gas Alarm horn as currently used, and the same horn operated with a GE 313 lamp in parallel. This is the type of bulb used as the alarm indicator light. Voltages across the horn coil, and across the horn input were observed in each case. The results are illustrated in Figures 1 and 2. Figure 3 shows the horn voltage with RFI suppression. It is felt that the circuit of Figure 2 should result in a decrease in radio interference, and may prolong horn life. An additional circuit tried was with a 0.1 μf capacitor parallel to the horn and the lamp. The use of this capacitor seemed to have an unpredictible effect on the overall operation of the flasher-horn-lamp circuit.

~~It was hoped that the use of the horn and lamp in parallel~~ would eliminate the interference of the horn on the flasher operation. On unit 30, variation of horn operation had no effect on the flasher. To check further on the effectiveness of paralleling the horn and lamp, a horn was operated from the circuit board checker, using ten (10) newly built circuit boards. In four cases, there was an erratic effect on the flasher when the horn was used alone, paralleled with the lamp or with both the lamp and the capacitor. Three showed no effect when the lamp was used, but were erratic when used with lamp and capacitor. The other three were perfectly steady when used with the lamp and capacitor, but were erratic when used with the lamp alone.

In no case were any irregular voltages seen on the power sides of the diodes.

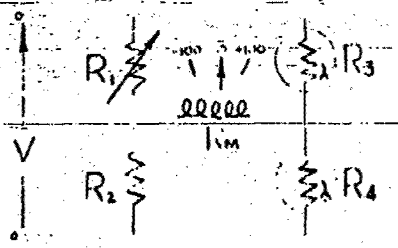
As a long term check on unit 30, the horn and alarm lamp were operated through the flasher relay (K-1) for approximately 700,000 cycles of $\frac{0.01 \text{ min}}{\text{cycle}}$ duration. Early in the test there were some extended "on" cycles, when the input voltage dropped to around 21 V. At this time various capacitor valves were paralleled with the horn and lamp. A valve of .47 μf was found satisfactory for that particular circuit board and horn combination.

Two conclusions can be reached at this time, though it is obvious that more detailed study would be required to establish an optimum circuit.

The foreign matter could not be positively identified but appeared to be similar to material used in the prefilter. It was also found that the preheater circuit was faulty causing the heaters to be full on which, when combined with poor air flow, caused the head to be abnormally hot.

This unit was cleaned and the heater control circuit repaired and the alarm subjected to additional laboratory tests at AAI. The unit still exhibited an excessive degree of instability although not to the extent experienced by CRDL personnel during their tests. A bridge circuit was therefore breadboarded for laboratory testing in an effort to isolate the cause of this drift. Testing has just been initiated on this set up and studies are to be made on the effects of light and temperature variations without the presence of other variables such as fluid flow, air flow, tape, etc.

A mathematical analysis of this circuit was performed to determine if thermal variations were of such magnitude as to render further consideration of this circuit unwise. The paragraphs following are the results of this analysis.



In the bridge circuit shown
R_1 and R_2 are resistors.
R_3 and R_4 are photocells.
R_M is the meter resistance.
V is the DC voltage.

The expression for meter current (I_M) for this circuit is:

$$I_M = \frac{V\,(R_2R_3 - R_1R_4)}{R_1R_2(R_3+R_4)+R_3R_4(R_1+R_2)+R_M(R_1+R_2)(R_3+R_4)}$$

It is easily seen that the condition for a balanced bridge (that is, $I_M = 0$) is when $R_2R_3 = R_1R_4$.

In the following cases described in this analysis, various values of R_1, R_2, R_3, R_4, and R_M have been substituted into the above expression in order to discover the extent of unbalance which may result from changes in photocell resistance with light or temperature.

In general, it has been found that the resistance of photocells varies in accordance with the following expression:

$$R = R_0\left[1 + S\,(T_0 - T)\right] \qquad \text{where}$$

R_0 is photocell resistance at temperature T_0.

S is percentage change per unit temperature.

For cells tested here, values for S have been found to range between 0.19%/°F and 0.23%/°F.

In the following cases shown where cells with different temperature sensitivities are used, the cells were so assigned to R_3 and R_4 so as to

cause the largest unbalance in the ALARM direction after the temperature effects were considered.

A number of meter relay coils were measured at room temperature and found to vary about 6 percent from 2.5 K. However, upon subjecting the meters to extreme temperatures, the coils were observed to change from a value of 2 K at -40°F. to a value of 3 K at +160°F. While the meter coil may not experience such extremes in use, it is kept in mind that the meter is thermally insulated from the interior of the alarm case and its face exposed. Consequently, the following calculations have been made considering meter resistance values of 3 K and 2 K, respectively, for high and low temperatures.

In addition, case temperatures were assumed to vary from 30°F. to 160°F. It is hoped that conditions do not vary so drastically as those imposed upon the bridge circuit here. Nevertheless, the aim of this analysis is to give an indication of the worst to be expected; hence, the most severe conditions were considered.

CASE I

The first case considered is the ideal case where both photocells are identical, having resistances of 1 K at room temperature and balance conditions. Further, both cells are at the same operating point.

$$I_M = \frac{V\,(R_2R_3 - R_1R_4)}{R_1R_2(R_3+R_4)+R_3R_4(R_1+R_2)+R_M(R_1+R_2)(R_3+R_4)}$$

By substituting $V = 17.5v$

$R_1 = R_2 = 5\ K \quad R_3 = 1\ K \quad R_M = 2.5\ K$

$I_M = -100\mu a$

It is possible to find what change in R_4 is necessary to produce an ALARM condition ($-100\mu a$). Similarly, by making $I_M = +100\mu a$ it can be found what change of R_4 causes MALF.

Tabulated here are the calculated

ΔR_4's for different meter resistances.

	Meter Resistance (R_M) 2 K	2.5 K	3 K
Change in R_4 necessary to give ALARM @ $-100\mu a$	$+122\ \Omega$ (+12.2%)	$+130\ \Omega$ (+13.0%)	$+143\ \Omega$ (+14.3%)
Change in R_4 necessary to give MALF @ $+100\mu a$	$-107\ \Omega$ (-10.7%)	$-117\ \Omega$ (-11.7%)	$-127\ \Omega$ (-12.7%)

CASE II

Next considered were cells, each having a room temperature resistance of 1 K, but with different temperature sensitivities of the extremes noted in photocell test batch.

CASE II A.

$$R_3 = R_{3_0}(1 + .0023\,\Delta T) = 810\,\Omega$$

$$R_4 = R_{4_0}(1 + .0019\,\Delta T) = 846\,\Omega$$

	R_M 2 K	R_M 2.5 K	R_M 3 K
Meter Current caused by Temperature rise 80°F. to 160°F.	I_M = -32 μa	I_M = -29 μa	I_M = -27 μa

CASE II B.

$$R_3 = R_{3_0}(1 + .0019\,\Delta T) = 1095\,\Omega$$

$$R_4 = R_{4_0}(1 + .0023\,\Delta T) = 1115\,\Omega$$

	R_M 2 K	R_M 2.5 K	R_M 3 K
Meter Current caused by Temperature drop 80°F. to 30°F.	I = -16 μa	I = -15 μa	I = -14 μa

CASE III

Cells R_3 and R_4 were assumed to vary ±10 percent from 1 K and have different temperature sensitivities.

$R_1 = 4.09$ K $\qquad R_{3_0} = 900\,\Omega$

$R_2 = 5$ K $\qquad R_{4_0} = 1100\,\Omega$

CASE III A

		R_M	
	2 K	2.5 K	3 K
Change of R_4 necessary to cause ALARM @ 100 μa		+142 Ω (+12.9%)	

CASE III B

$$R_3 = R_{3_0}(1 + .0023\,\Delta T) = 734\,\Omega$$

$$R_4 = R_{4_0}(1 + .0019\,\Delta T) = 933\,\Omega$$

		R_M	
	2 K	2.5 K	3 K
Meter Current caused by Temperature rise 80°F to 160°F		$I_M = -33$ μa	$I_M = -30$ μa

CASE III C

$$R_3 = R_{3_0}(1 + .0019\,\Delta T) = 986\,\Omega$$

$$R_4 = R_{4_0}(1 + .0023\,\Delta T) = 1227\,\Omega$$

		R_M	
	2 K	2.5 K	3 K
Meter Current caused by Temperature drop 80°F. to 30°F.	$I_M = -14.5$ μa	$I_M = -14$ μa	

In the preceeding examples it is assumed that the bridge was initially balanced and then the temperature changed. Further we assume the photocells are positioned sufficiently close together so that they are always at the same temperature.

The results of Cases II and III indicate that the worst to be expected is temperature drift of about 15 μa for low temperatures and 30 μa for high temperatures if the unit was initially balanced at room temperature.

Little change results from different magnitudes of photocell resistance as can be seen by comparing Case III meter current with that of Case II. Practically all of the drift may be attributed to differences in photocell temperature sensitivities.

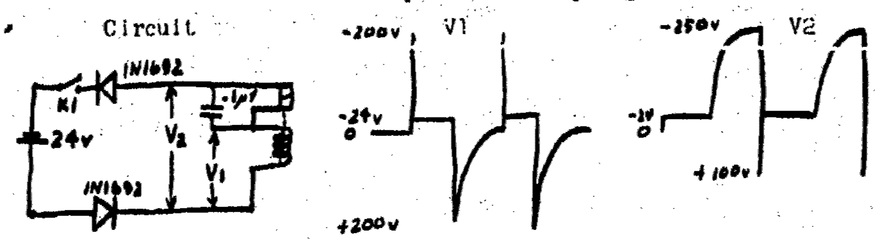
Data sheets which have been kept for a bridge circuit head show that the greatest air blank observed was 37 μa. If in a unit such a photometer head combined the greatest air blank observed (37 μa) with the greatest deflection expected from the earlier calculations (33 μa), the resultant meter deflection of 70 μa would still be comfortably short of the ALARM level when set at 100 μa.

Since laboratory observations do not bear out the results as obtained from calculations, it is suspected that the photometer head tested in the laboratory fails to keep both photocells at the same temperature. Investigation into reasons for full-scale drifts experienced in the laboratory will attempt to eliminate such large drifts through closer physical positioning of the photocells and more even heat distribution in the head.

a. The use of a lamp bulb across the Edwards horn now in use appears to reduce or eliminate sharp voltage spikes normally encountered in operation.

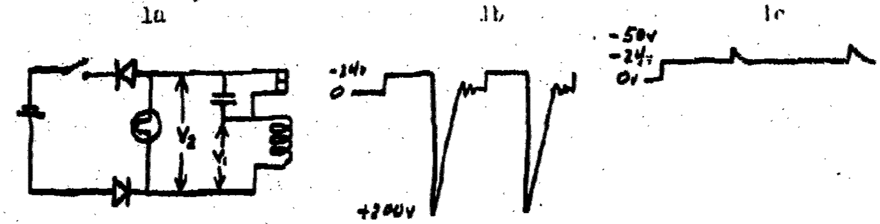
b. The present flasher circuit is capable of operating the alarm horn and lamp combination for a length of time in excess of that which might normally be encountered in a normal service life of an alarm.

It was the opinion of many who heard the 100 "beep"/minute horn signal that this type of intermittent audio signal caught and held their attention more than the present steady signal.



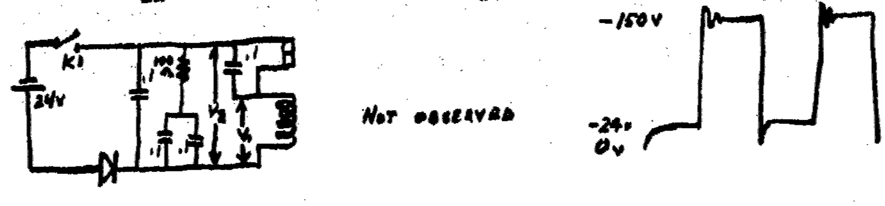
Horn with only diodes added

1a 1b 1c



Horn with lamp

2a 2b 2c



Horn and RFI suppression

3a 3b 3c

f. Inlet-Heater Studies

The preheater circuit is now being studied to ascertain if instability could occur at high and low temperatures. Action in this area was felt to be necessary based on reports from CRDL personnel that temperatures at the prefilters were not consistant from run to run. In addition, measurements made on the preheater voltage at room temperature frequently varied by a significant amount.

Data are now being taken on the output voltage of the heater and the input signal from the thermistor and a photometer head has been completely instrumented to record air temperatures and temperature gradients across the head. An insufficient amount of information has been obtained at this time but testing will continue in the forthcoming report period.

g. Waterproofing Tests

In the previous progress report, it was stated that alarms Nos. 35, 36 and 37 were returned from Service Tests at Fort Benning to correct unexplained failures. These failures were subsequently traced to condensation dripping from the air line onto the printed circuit board which caused short circuits at several points. As an interim measure, a drip board was installed over the circuit board but AAI began to investigate various materials for coating both sides of this component rather than only the track side as had been done prior to this time.

It was decided initially that the waterproofing compound then in use should not be used in this application even though previous tests demonstrated its resistance to attack by the reagent solution. This decision was based on maintenance considerations. A total of five different materials were tested and all but one were penetrated to varying degrees by the solution after 12 to 24 hours' immersion.

One sample, Hysol No. 12-007 was not affected and was therefore subjected to further testing. The circuit board was immersed in an 8 mg solution of O.D.N. and sodium pyrophosphate peroxide for a total of 72 hours during which time the temperature was varied between -40°F. and +115°F. At the conclusion of this test series, no visible signs of deterioration were detected and this initial phase of testing was regarded as having been satisfactorily completed.

Two printed circuit boards were then coated with the Hyrol compound and subjected to alarm tests to determine if this material would cause a heat build up and bring about circuit instability. The voltage regulator performance was monitored over numerous twelve-hour runs with a Fluke Voltmeter and in no case did the drift exceed the design tolerance of ± 0.1 volts.

Based on the above tests, it is concluded that the Hysol No. 12-007 waterproofing material is acceptable for use on the printed circuit board and is compatible with overall alarm performance requirements.

h. Lamp Socket Corrosion

On several occasions the alarm and malfunction lights have not given the visual indication when an alarm or malfunction condition existed. Inspection revealed that the lamp sockets were corroded to a point where continuity was either intermittent or non-existant.

The Dialite Company, fabricators of the receptacles, was contacted about this problem and it was learned that a similar item, conforming to military specification, was immediately available as replacements. Six samples are being forwarded to AAI and upon receipt, will be subjected to tests to determine their adequacy as replacements. The present components are commercial items and do not conform to the applicable military specifications. It is planned that the new units be subjected to rigid proof testing including immersion in the reagent solution, water and in an atmosphere saturated with the chemical solution. If acceptable, alarm testing will follow.

i. Reflective Tape Tests

During the CONARC Service Tests the alarms were allowed to run beyond the normal twelve-hour duty cycle until all of the tape was exhausted. At this time a malfunction indication should have been given but on a number of occasions, the alarm was sounded instead.

The tape rolls were inspected at Fort Benning to determine if the reflective material, which had been added to the last few inches of tape, was mutilated or damaged. In most cases the tape was creased in a number of places normal to the line of tape advance. It was the diagnosis of liaison personnel that the deformations were causing light to be randomly reflected to or away from the photocell producing either malfunction or alarm conditions respectively.

Twenty-three samples of this portion of the tape were forwarded to AAI for test in alarms to verify that the difficulty was positively attributed to the tape rather than random alarm performance. These specimens were "left-overs" from previous runs but the area of the tape in question had not previously been unwrapped from the spool. Every specimen (12) tested on alarm No. 41 gave an alarm indication; the eleven (11) samples run on alarm No. 43 gave malfunction indications.

These results would tend to substantiate the opinion that the problem was one of random alarm performance rather than tape condition. However, subsequent test with smooth reflection material on the tape

consistently produced a malfunction condition. It was then concluded that both were partially responsible and that a new approach must be taken to solve this problem reliably. Action will be taken by both AAI and CRDL during the next reporting period to solve this problem.

j. Air Pump Motor

Air pump motor currents were measured on five alarms (38, 39, 41, 42 and 43) to determine if the motor current is a function of air flow. These tests were in conjunction with using a current sensing device in the motor supply line to accomplish the same objectives as for the baro switch.

Tests were run at 28, 24 and 21 volts to simulate battery decay during a normal twelve-hour duty cycle. From the data taken, it was concluded that such an approach was unwise in the present system since air pump motor current differed significantly at each voltage with a given air flow rate.

4. Summary of Fort Benning Service Test Results

ALARM 14 Operating time to end of report - 505 hours

There were three false alarms; one due to drift, one caused by the tape coming off the tape drum, and the third probably due to a defective photometer lamp.

Nine malfunctions occurred. Seven were due to low battery voltage, one from moisture on the P.C. board, and one from dry tape.

Other failures were:

a. The solution pot handle came loose where it was fastened by a peened rivet.

b. The needle on the meter relay fell off.

c. Third echelon cleaning of the head was required twice.

d. The head had to be replaced when the meter could not be adjusted above 90μa.

There were three road tests on an M-113 armored personnel carrier, each of approximately five hours duration. The unit operated satisfactorily mechanically, but failed to respond to GF agent due to excess dust on the prefilter.

ALARM 21 Operating time to end of report period - 135 hours

This alarm was operated from 7 September to 21 September when it was returned to AAI for rework on the tape drum assembly. During this time there were three false alarms, one due to drift, and two which

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were unexplained, due to operator resetting and continuing operation before an evaluation could be made. Four malfunctions occurred, three due to low voltage, and one unexplained, occurring about the same time as one of the unexplained false alarms. Other difficulties were a failure of the transport motor, a loose bearing at the tape drum cam, and two failures of the tape drum cam due to excessive wear of the cam.

ALARM 26 Operating time to the end of the report period - 213 hours

This alarm was operated from 9 September to 21 September when it was returned to AAI for rework on the tape drum assembly. During this period there were no false alarms but three malfunctions; one due to low battery voltage, one due to dry tape caused by stretching of the peristaltic pump, and the third due to an undetermined cause, possibly dry tape. In the second malfunction, the pump was replaced. Other difficulties were one case of the garter spring coming unhooked, and three failures of the tape drum to transport properly. In all three instances, the cam surface was deformed, with the bearing being loose in one instance.

ALARM 35 Operating time to end of report period - 636 hours

During this period there were six (6) false alarms; four (4) were due to meter drift, one was due to the tape running off the tape drum and the other due to a failure of the microswitch S-3. This switch was replaced. There were three malfunctions; one due to low battery voltage, and two due to dry tape. Examination showed that the peristaltic pump was worn. This was replaced.

The head was cleaned once, at third echelon level. Other difficulties encountered were

a. The set screw on the air pump loosened once, requiring resetting.

b. Corrosion on the lamp socket for the alarm lamp prevented this from turning on during a check.

c. The rulon bearing in the tape drum seemed to have loosened. This did not impair operation.

d. The horn failed to work on some alarm checks.

There were three road tests on an M-113, each of about five hours duration. The unit operated satisfactorily during the runs, but was insensitive to GF agent when dust accumulated on the prefilter.

ALARM 36 Operating time to the end of this report period - 635 hours

Three false alarms occurred; two were caused by drift. The third occurred during handling when the operator brushed against the adjust knob, changing the meter setting to an alarm level. A shield is to be designed to prevent recurrence of this.

Six malfunctions occurred. Of these, two were caused by low battery voltage, two by moisture on the circuit board, one by dry tape due to running out of solution, and one caused by a broken diode connection on the circuit board.

During alarm checks, the horn hesitated at times as much as five seconds before sounding.

The peristaltic pump was replaced at the same time as the ones on Units 35 and 37, as some wear was evident.

There were four road tests, three of five hours each on an M-113 and one 35 mile jeep ride. Performance was satisfactory during the test, but dust on the prefilters prevented detection of GF agent.

ALARM 37 Operating time to the end of this reporting period - 635 hours

There were six (6) false alarms during this period. Three were caused by meter drift, two were caused by the reflective surface at the end of the tape, and one was due to operator error in that the alarm was placed into operation when the meter could not be adjusted above 88μa. The one malfunction during this time was caused by dry tape. The peristaltic pump was replaced because of wear.

On one occasion, the tape wrapped around the drum, and then broke. Build up of tape thickness stalled the transport motor during transport, therefore no malfunction or false alarm signal was given. The head had to be cleaned twice at third echelon level. The horn operation was unsatisfactory, even after adjustment.

The alarm was given four (4) road tests, three in an M-113 for five hours each time, and one 35 mile jeep run. Excessive dust on the

prefilter prevented response to GF agent after road tests. The unit operated satisfactorily otherwise during the road tests.

General Observations on the Fort Benning Tests

1. Dust on the prefilter is a major problem area and corrective action must be taken.

2. Photometer drift continues to be the major cause of false alarms.

3. The 4.2 amp-hour ni-cad battery does not give reliably a full 12 hours of operation using the present recharging and servicing method.

4. The reflective surface on the end of the tape does not give a malfunction consistently. Most of the malfunction indications given occurred at the end of a cycle rather than when the surface first came under the photocell. Therefore, a more dependable method of detecting tape run out is required.

5. A method of preventing the tape from running off the front edge of the tape drum is needed.

6. The alarms seem capable of withstanding the vibration of moving vehicles.

AAINC E13BA

C. General

On 6, 9 and 11 October 1961 conferences were held at CRDL and AAI for the purpose of establishing a course of action to be taken to correct the dificiencies found as a result of Service Tests and Final Engineering Tests. As a result, it was agreeded that joint efforts would be performed to resolve the following problems.

1. Initial Photometer Drift

a. Test program to be performed to determine those modifications which are necessary to the present procedures that would eliminate or reduce initial drift problems with the standard photometer head.

b. Photocell studies to determine the detail characteristics of both the 602 and 605L photocells.

c. Design and testing of the automatic null circuits.

d. Design and test of the bridge type circuit.

2. Action to eliminate effects of condensation on the printed circuit board, photometer head and prefilter lever support.

3. Develop a device which would reliably indicate when the tape has been expended.

4. Action to improve photometer maintenance, replacement and cleaning.

5. Development of a positive lock and guide mechanism for the pay out spool to eliminate tape run off and breakage.

6. New design of prefilter holder to facilitate removal of the prefilter.

7. Design of a protective device to prevent moving the null pot during alarm use.

8. Continuation of studies to improve the present audible warning device and conduct studies on a motor driven sound device and other approaches.

9. Instruction Book changes to reduce operator error. Necessary inputs from CRDL liaison personnel at FortBenning by 13 December.

10. Fort Benning feels that the present vehicle installion kit for mounting the alarm on various Ordnance vehicles is unsatisfactory.

11. Development of an improved remote alarm device

12. Action to eliminate condensation in the vicinity of the malfunction and alarm indicator lights and replacement of present lamp sockets with improved components.

13. Investigation of the effects of case swelling causing alarm leakage. Particular emphasis will be placed on the thickness of the fluid pot guides and the pot handle stop.

14. Investigate charging procedures to minimize fall off in battery capacity.

15. Development of a stable conversion filter.

16. Studies to determine causes and extent of reduced alarm sensitivity at high temperature. This task does not include reaction temperature studies.

17. Studies to determine the stability of the present preheater circuit and to evaluate other approaches for control of the preheater.

18. Perform tests to determine sensitivity at low temperature ambients.

19. Evaluation of exit air outlet wind reflector.

Schedules and work scopes are now being prepared by AAI and CRDL which will be put into effect immediately.

IV. FUTURE PROGRAM

Major efforts during the coming period will be in accordance with the program outlined in paragraph 3.c. above. Other efforts will be directed towards the completion and testing of alarms for delivery to CRDL.

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